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ABSTRACT

The study examined the effects of questions on learning among 90 intermediate level educable mentally retarded children. Four types of learning were identified as relevant remembering, incidental remembering, relevant inferring, and incidental inferring. Results indicated that question position was an important variable in influencing the learning of EMR children, with Ss who received post-questions performing consistently better than those who received pre-questions. A significant interaction between question type and relevant criterion type was also found: children who received "remembering" training questions scored higher on the remembering relevant criterion test than children who had received "inferring" training questions, and children who received "inferring" training questions performed better on the inferring relevant criterion test than children who had received "remembering" training questions. (Author/SBH)

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INFORMATION PROCESSING AS A FUNCTION OF QUESTION TYPE AND POSITION

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Abstract

The purpose of this study was to examine the effects of questions on learning among mentally handicapped children. The four types of learning were identified as relevant remembering, incidental remembering, relevant inferring, and incidental inferring.

Results indicated that question position was an important variable in influencing the learning of educable mentally retarded children, with subjects who received post-questions performing consistently better than those who received pre-questions. A significant interaction between question type and relevant criterion type was also found; children who received remembering training questions scored higher on the remembering relevant criterion test than children who had received inferring training questions, and children who received inferring training questions performed better on the inferring relevant criterion test than children who had received remembering training questions.

INFORMATION PROCESSING AS A FUNCTION OF QUESTION TYPE AND POSITION

Research on mathemagenic behavior indicates that questions interspersed in prose may be used to reinforce specific study habits and may act to evoke study behaviors (Faw & Walker, 1976; Rothkopf, 1970). The impetus for these investigations dealing with the insertion of test questions in prose materials was provided by Hershberger (1964) and Rothkopf (1966) as an extension of the commonly employed programmed instruction principle of overt responding. Since these initial studies a fairly consistent pattern of results has emerged. Studies by Rothkopf (1966, 1972), Rothkopf and Bisbicos (1967), Rothkopf and Bloom (1970), Frase (1967, 1968), Boyd (1973) and Snowman and Cunningham (1975) and a review by Faw & Walker (1976) support the following general conclusions: 1) inserted questions which appear before the material to which they relate (pre-questions) have a substantial specific facilitative effect but no general facilitative effect, 2) inserted questions which appear after the material to which they relate (post-questions) have a substantial specific facilitative effect as well as a small general facilitative effect on post-test scores. Thus it appears that students are able to adapt their study behavior to the demands of these interspersed test-like events.

One of the problems in teaching mentally handicapped individuals seems to be their difficulty in identifying the important and critical features of the material to be learned. Zeaman and

House (1963) have argued that the observed learning deficit of retarded children may be accounted for by a lack of attention, and that the secret to teaching the retarded child lies in engineering his attention. Drawing on this work, Denny (1964) hypothesized that the performance of mentally retarded children may be due to a deficit in incidental learning, and contended that the basic attentional problem hypothesized by Zeaman and House (1963) may result in poor incidental learning. Several experimenters have reported results consistent with this hypothesis (e.g., Goldstein & Kass, 1961; Semmel & Williams, 1968). It was thus the intent of this study to examine the extent to which different types of questions placed in different positions could have both specific and general facilitative mathemagenic effects on the learning of retarded children. More specifically it was hypothesized that this effect would be additive (Boyd, 1973) in effecting both the attention to and retention of the information to be learned.

Method

Subjects

Ninety intermediate level educable mentally retarded children served as subjects in this experiment. The 54 males and 36 females in the sample ranged in chronological age from 114 months to 168 months ($\bar{X}$ = 141.60, SD = 10.90) with mental ages ranging from 74.48 months to 132.88 months ($\bar{X}$ = 98.42, SD = 13.10). The children were randomly selected from special education classes in each of the 11 cooperating schools after the respective teachers had eliminated all children in their classes who had either hearing problems, speech

problems, or severe behavior problems.

Materials

The subjects listened to a short high interest-easy vocabulary mystery story of approximately 2400 words, which was divided into 10 separate sections of approximately equal length. A reading of the story by a professional teller of children's stories was recorded on audio tape.

Each of the 10 sections yielded a total of four questions, two of which required remembering and two inferring. The operational definitions of these terms are derived from the work of Lynch and Ames (Note 1). The most important distinguishing characteristic of remembering questions is that they call upon the child to recall something. He may be asked for a straightforward summary of something or for a piece of information. They do not call upon the child to interpret or draw conclusions from data.

Inferring questions are distinguished by the fact that they call upon the child to arrive at his own interpretations, deduction, or conclusion from available information. A task in this category asks the child to "go beyond the data" and arrive at some sort of conclusion. The answer to one of the remembering questions and one of the inferring questions could be found in the first half of each section. The answer to the remaining remembering and inferring questions could be found in the second half of each section.

The criterion test was made up of two question types: remembering and inferring. Each test was composed of 20 free recall type items in total, but each subject received only one type of test

(i.e., either remembering or inferring, but in no case both).

Each criterion test consisted of two subtests: a relevant and an incidental subtest. The "relevant" questions were those which had been asked earlier during the listening task and as such had been heard by the subject once before. The incidental subtest questions were based upon the same story which the subject had listened to earlier, but were questions he had never heard before. All items were classified according to type by two people who had demonstrated consistent reliability with the Lynch-Ames (Note 1) category system.

Procedure

Subjects were randomly selected from cooperating classrooms and accompanied to the experimental room by one of the six experimenters. After establishing rapport with the subject, the experimenter introduced the story with the general statement that the story was about a young boy who lives in a city and the problems he has when he tries to catch some bank robbers. The subject was also told to expect a surprise ending. The experimenter stressed that it was important to listen carefully as he was interested in how much the subject learned from the story and that the subject would be asked questions after the story was over.

During the story the experimenter systematically introduced the questions. The questions were typed on a sheet of paper which the experimenter held before him. The experimenters had been instructed to read the questions as they were printed. These questions were of two types (remembering or inferring) and in one of two positions (pre- or post). In the pre-remembering question condition, the questions

were read to the Ss before each paragraph was heard, and the subjects were instructed to respond to these questions orally after listening to each of the paragraphs. No informative feedback was given. The experimenter gave only an indiscriminate, accepting response by saying "Thank you" or "O.K.," but did not indicate whether the answer was right or wrong. The pre-inferring questions group was asked one inferring question before each paragraph was heard and responded after they heard the paragraph. In the post-question conditions the questions were asked one at a time, but after each section had been heard; the subjects responding immediately to the question. There were a total of ten paragraphs and, thus, ten questions. Control group subjects received no questions but did listen to the same short story. Instead, they had a short 20-second break between each paragraph during which they just sat quietly. All subjects' responses to all questions were tape-recorded and the experimenter wrote down the subjects' responses verbatim as well.

After the story was over, there was a 15-minute rest period during which the subject and experimenter played with Cuisenaire Rods. Each subject was informed before the 15-minute break that after they played for awhile, they would have a short test.

After the rest period the experimenter administered the 20-item criterion test. Each of the questions was typed on a sheet of paper from which the experimenter read the questions to the subject. The subjects' responses were again written down exactly as spoken. Each item was read no more than two times in total. All questions and answers were also tape-recorded during this test period.

Scoring of the Tests

A random sample of the answers which the experimenters wrote down were checked by two people independently against the corresponding audio tape for accuracy of the written response. Inasmuch as this showed the written response to be accurate more than 99% of the time, the scoring of the answers was done on the basis of the responses which were written down by the experimenters as opposed to the taped version of the subjects' responses.

The answers to each question were judged in turn; i.e., all of the responses to a given question were judged before the answers to another question. Each response was compared to that on the answer key. The answer key was made up in advance of any judging and was based upon the information contained in the story. Each response could receive one of three possible scores. An answer which was completely correct earned 2 points, 1 point was given for half credit, and 0 points for an incorrect response. All of the answers were judged in such a way that the judge had no knowledge of the group to which the subject belonged. After all answers were judged, an estimate of reliability was obtained by rescoring a random sample of answers. This produced 94.5% agreement between the first and second scoring.

Results

The results are presented here under two main headings: results based upon the between trial scores, and results based upon the scores of the delayed criterion tests.

Between-Trials Scores

A 2x2x2x6 ANOVA design with the location of information in section factor as a repeated measure was used to analyze the responses given to the questions asked during the listening task. The effects of question type (T), question position (P), location of information in section (I) and experimenter (E) were assessed, and are reported in Table 1.

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Insert Table 1 About Here

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The main effects of question type (remembering and inferring) ($F = 11.01$, $df = 1/48$, $p < .005$) and question position (pre-and post) ($F = 8.72$, $df = 1/48$, $p < .005$) were significant. Those subjects who received remembering questions did significantly better ($\bar{X} = 10.87$) than did those receiving inferring questions ($\bar{X} = 7.78$); and those subjects receiving post-questions scored significantly higher ($\bar{X} = 10.67$) than those subjects who received pre-questions ($\bar{X} = 7.47$). The two-way interaction of question position (P) and location of information in section (I) was also significant ($F = 14.92$, $df = 1/48$, $p < .001$), as was the three-way interaction of question type (T) with question position (P) and experimenter (E), ($F = 4.20$, $df = 5/48$, $p < .005$).

Results of the planned comparison test (Snedecor & Cochran, 1967) of the P x I interaction showed that subjects performed better on items where they received a post-question and the information needed to answer the question was in the last half of the section

than on items where they received a pre-question and the information was in the first half of the section ($p < .005$). On items where the information needed to answer the question was presented in the first half of the section, subjects who received post-questions performed better than those who received pre-questions ($p < .05$). On items where the information needed to answer the question was presented in the last half of the section, subjects who received a post-question out-performed those subjects who had received pre-questions ($p < .05$).

Delayed Criterion Test Scores

These results are based on subjects' performance on the delayed (after 15-minute rest period) criterion test. There were 20 items on this criterion test. Ten of these items were "relevant" items--the questions which were asked by the experimenter during the listening activity, and 10 were "incidental" items--questions relating to the material covered in the story but not asked during the listening activity. Thus, the criterion test was composed of two subtests.

Though the control groups received all 20 items as the criterion test, it must be pointed out that, in fact, they have no "relevant" items as a result of their having received no training questions during the listening activity. The same situation exists for those groups who received one type of training question and another type of question on the criterion test. Because the questions they received on the criterion test were of a different type than those they heard during the listening activity, they really have no "relevant" criterion test questions, either. The term "relevant,"

then, is used to describe a subset of 10 items on the criterion test and not any of the treatment conditions. The same applies for the term "incidental" which refers to the remaining set of 10 items. Table 2 contains the means and standard deviations of subjects' performance on these delayed criterion tests.

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Insert Table 2 About Here

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Four separate 2x2 ANOVA's were done on each of the four dependent measures: remembering relevant scores, remembering incidental scores, inferring relevant scores, inferring incidental scores. These data are reported in Table 3.

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Insert Table 3 About Here

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The analysis of the scores of the relevant remembering and inferring dependent variables showed question type to have a significant effect in both cases ($F = 8.48$, $df = 1/32$, $p < .01$ for relevant remembering variable; $F = 6.74$, $df = 1/32$, $p < .05$ for relevant inferring variable). An inspection of the means showed that on the relevant remembering criterion test those subjects who received remembering training questions out-performed those who received inferring training questions. On the inferring criterion test, however, the results were just the opposite--those subjects who received inferring training questions performing better than those who received the remembering training questions. No significant

effects were obtained as a function of the question position factor on any of the delayed dependent measures. The analysis of the incidental scores on both the remembering and inferring criterion tests showed no significant differences.

The results were further analyzed for all experimental and control groups with the analysis of each criterion type done separately. Results of these 5x2 ANOVA's (see Table 4) showed that

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Insert Table 4 About Here

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subjects did best on the relevant criterion items compared with the incidental items on both the remembering (F = 46.42, df = 1/40, p<.001) and inferring (F = 7.66, df = 1/40, p<.01) criterion tests. Though the analysis did not show any significant differences on group main effect for either of the criterion tests, it did indicate a significant interaction between group and relevance of test on the remembering criterion test (F = 3.68, df = 4/40, p<.05). The Newman-Keuls method of multiple comparisons (Winer, 1971) was used to analyze this effect. Results of this comparison showed that the pre-question remembering training question-remembering criterion test relevant score was significantly higher than all other relevant and incidental scores, including the same type criterion test control group, with the exception of the post-question remembering training question-remembering criterion test group relevant score (p<.01). The post-remembering training question-remembering criterion test group relevant score proved to be significantly higher than all of the incidental

scores ($p<.01$) and higher than the relevant score of the pre-question inferring training question-remembering criterion test group ($p<.05$).

Discussion

The between-trials data suggests that question position is an important variable in influencing the learning of educable mentally retarded children. As a main effect, subjects who received post-questions performed consistently better than those who received pre-questions. This effect, though significant, was in a direction opposite of what was expected. It was hypothesized that the pre-question condition would cue the subject to listen for the appropriate information (i.e., the answer) and, thus, enhance his retention of the critical information. This effect, it was thought, would be superior to the effect of the expectation held by others who were receiving post-questions, that they would be asked a question about the section of the story they had just heard.

Moreover, it was thought that the subjects would perform better on trials where they received pre-questions and where the information was close, i.e., in the last half of the section. The results again indicated just the opposite. Subjects did better on items where they received a post-question and where the information needed to answer the question was in the last half of the section.

These findings were thought to be explained best by interference theory, with the better post-question performance of subjects being accounted for by the retroactive interference of the great amount of information presented after the question. Thus, by the time the experimenter called for the response to the question in the pre-question

condition, the subjects may well have forgotten the question.

Interference theory may also be used in explaining the interaction results where the subjects performed better on the items which were post-questions and where the information needed to answer the question was in the last half of the section, than on any other combination of the two variables. A close look at the means for these groups shows that subjects did best on items where there was at least opportunity for interference; the worst where there was the greatest opportunity for interference; and their performance was at a point in-between these two groups when the opportunity for interference was at a point half-way between these two extremes.

The significant interaction between question type and relevant criterion type--that is, children who received remembering training-questions scored higher on the remembering relevant criterion test than children who had received inferring training questions, and children who received inferring training questions performed better on the inferring relevant criterion test than children who had received remembering training questions --was taken as support for the general thesis that "the activities a student engages in when confronted with instructional tasks are of critical importance in determining what he will learn" (Anderson, 1970, p.349). In general, then, it can be said that the different types of questions may only be useful to the extent that they facilitate the "desired" kind of learning which must be defined in terms of a teacher's objectives for a particular lesson.

It is not completely clear, however, whether this effect is a function of the facilitating effect of the appropriate type question

relative to the criterion task, or due to the suppressing effect of the inappropriate question type. A close inspection of the means (Table 2) indicates that the inappropriate type question group performed slightly worse than the control group in each case. Further research will be needed to clarify this clouded issue.

Nevertheless, this significant interaction effect suggests support for what Rosenshine and Furst (1971) have called the "cognitive process" opportunity-to-learn phenomenon. This phenomenon refers to the important consideration of whether or not the level of the criterion instrument was relevant to, and of the same type as, the instruction.

Though only the remembering criterion test produced a difference between the relevant experimental and the control group, this finding is suggestive of the importance of teacher questions during instruction for which the children have a reasonable expectation for giving a correct response. The difficulty of the inferring questions and ensuing low percentage of correct responses with accompanying low variance, likely contributed to the resultant nonsignificant difference between the relevant experimental groups and control on this criterion test.

The general conclusions from the data collected in this study are, then, that questions seem to be of value in the teaching of mentally handicapped children when they are asked at the right time and with the right objective in mind. The right time is defined as being in close temporal proximity to the presentation of information and after the presentation of this information. Furthermore, the questions seemed to be of greatest value when they were of the same type as the type of question asked on the criterion test.

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Table 1

ANALYSIS OF VARIANCE OF BETWEEN TRIALS TOTAL SCORES

Source	df	MS	F
Question Type (T)	1	112.01	11.01*
Question Position (P)	1	88.67	8.72*
Experimenter (E)	5	5.52	<1
Location of Information in Section (I)	1	1.56	1
T x P	1	27.56	2.71
T x E	5	4.29	<1
P x E	5	2.76	<1
T x I	1	.01	<1
P x I	1	39.06	14.92**
E x I	5	2.11	<1
T x P x E	5	42.75	4.20*
T x P x I	1	2.51	1.16
T x E x I	5	2.59	<1
P x E x I	5	4.25	1.62
S(T x P x E)	48	10.17	
T x P x E x I	5	2.19	<1
SI(T x P x E)	48	2.62	

* $p < .005$
** $p < .001$

Table 2

MEANS AND STANDARD DEVIATIONS OF DELAYED CRITERION TEST SCORES

(Based on a possible total of 20 points)

Group	Relevant		Incidental	
	M	SD	M	SD
Criterion Test 1 (Remembering)				
Remembering Pre-Questions	13.55	3.71	6.44	2.88
Remembering Post-Questions	11.67	5.12	6.33	3.46
Inferring Pre-Questions	7.88	4.40	6.33	2.69
Inferring Post-Questions	9.22	3.23	7.00	4.56
Control (No Questions)	10.22	4.42	6.11	3.41
Criterion Test 2 (Inferring)				
Remembering Pre-Questions	5.44	2.92	3.56	3.28
Remembering Post-Questions	6.11	1.83	6.11	5.37
Inferring Pre-Questions	8.78	3.53	7.67	3.77
Inferring Post-Questions	8.66	4.69	6.89	4.96
Control (No Questions)	8.11	5.46	4.67	2.40

Table 3

2x2 ANOVA'S ON DELAYED CRITERION SCORES

WITHOUT CONTROL GROUPS

Source	df	MS	F
Relevant Remembering			
Question Type (Q)	1	148.03	8.48**
Question Position (P)	1	.69	<1
Q x P	1	23.36	1.34
Error	32	17.46	
Incidental Remembering			
Question Type (Q)	1	.69	<1
Question Position (P)	1	.69	<1
Q x P	1	1.36	<1
Error	32	12.07	
Relevant Inferring			
Question Type (Q)	1	78.03	6.74*
Question Position (P)	1	.69	<1
Q x P	1	1.36	<1
Error	32	11.58	
Incidental Inferring			
Question Type (Q)	1	53.78	2.74
Question Position (P)	1	7.11	<1
Q x P	1	25.00	1.27
Error	32	19.63	

* $p < .05$
** $p < .01$

Table 4

ANALYSIS OF VARIANCE OF REMEMBERING AND INFERRING CRITERION TEST SCORES WITH CONTROL GROUP

Source	df	MS	F	p
Remembering Criterion Test				
Group (G)	4	25.46	< 1	
Relevance of Test (R)	1	317.34	46.42	<.001
Error S(G)	40	23.01		
G x R	4	25.18	3.68	<.05
Error SR(G)	40	6.84		
Inferring Criterion Test				
Group (G)	4	39.21	1.62	n.s.
Relevance of Test (R)	1	60.84	7.66	<.01
Error S(G)	40	24.14		
G x R	4	7.09	< 1	
Error SR(G)	40	7.94		